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THE TELEGRAPHS OF THE ARGENTINE REPUBLIC.

Nothing impresses one more with the progress of telegraphy than the growth which it has acquired. and the rapid advances which it has made in countries where until within the last few years it was altogether unknown, and where the establishment of a telegraph system was till then a subject not even dreamt of.

The official report of the telegraphs of the Argentine Republic by the Director-General, Mr. Charles Burton, has just reached us.

The Government telegraph system dates from the year 1870. In that year 129 miles of line were erected, and this has year by year gone on increasing until it now reaches 2618 miles of line, carrying a total mileage of wire of 5218 miles. Siemens's iron posts are employed on 1,448 miles; wooden poles of the country, in their natural state, have been made use of on the remaining 1170 miles. In addition, however, to this, there are various private undertakings, which have either been "subventioned" by the National Government, or belonging to the various railway companies in the state. These, including a two-wire line of 32 miles (belonging to the River Plate Telegraph Company), have 1528 miles of line, carrying 2841 miles of wire, which, added to the purely national telegraphs, give a grand total for the Argentine Republic of 4146 miles of line, and 8059 miles of wire.

These lines have been erected by private contractors, at a cost ranging from 500 "hard"* dollars per mile for lines with iron posts, to 384 "hard" dollars per mile for those with wooden poles.

The national lines are maintained by the Government with a staff at present of one director-general, one mechanic, three inspectors, six "line repairers," and fifty-seven linemen. The latter seem to be but poorly paid; their actual salary is forty hard dollars per month, "with which (we quote the words of the report) they have to buy and maintain a sufficient number of horses, pay their extra expenses when they are out, besides rent and ordinary cost of living at the point where the office is situated, and where they must fix their residence."

Mr. Burton on this subject pertinently remarks, "It is false economy to allow a practical lineman accustomed to the specialities of his section, and acquainted with the nature of the ground in which it is situated, to leave the service, instead of giving him a salary with which he could satisfy the ordinary necessities of life."

The Morse instrument is universally employed throughout, and the alphabetical signs are those adopted by the European International Convention, with the exception that — - - - — is used for ll, a combination of frequent occurrence in all the dialects of the Spanish language.

The instrument is not, however, equal to the pressure which from time to time suddenly arises on the trunk lines, and some other system must be introduced to augment the rate of working of the ordinary Morse. The only instrument which has hitherto been tried in addition to the Morse is the Hughes, which, as one would naturally expect, has failed to accomplish the end in view. Without special instruction in its management, and perfect familiarity with all the mechanical details, Hughes's apparatus cannot be considered in any way superior to the Morse for the despatch of traffic. Mr. Burton accordingly urges upon the Government the necessity which exists for his proceeding either to England or the United States, and personally inspecting the improvements which have been made in the transmitting apparatus of these countries during the last five years. We doubt not that the wants which are felt could easily be satisfied. The introduction of duplex working, or the establishment of an automatic system on the trunk lines, would, we are sure, do all that for several years to come could possibly be required of them.

There are in all sixty offices, which are manned by a staff of 114 telegraphers (including clerks in charge), five counter clerks, and sixty-seven messengers. At the great majority of these only one instrument is fixed. Rosario can boast of seven. They are kept open to the public up to 4.30 p.m., although telegrams proceeding from other lines, or from the press, are received up to 7 p.m. Government telegrams are of course received at any hour when there are clerks at the offices.

The qualifications for the appointments of telegraphers, are good penmanship and a perfect knowledge of orthography. The minimum age at which they are admitted—eighteen years—might with advantage be reduced; the mechanical art of telegraphing does not require the mental powers to be matured; a healthy lad commencing at, say, from fourteen to sixteen, will, when he has reached the age of eighteen, be found, if at any period of his career, an expert manipulator.

We are glad to observe that, as in the postal telegraph department of England, an outlet is afforded in this direction for the employment of female labour. The first female telegrapher, we read, was appointed to the service on January 1, 1873, but since then no addition to the number has been made. This, however, must not be attributed to any idea as to the inaptitude of female labour for telegraphy; Mr. Burton is, on the contrary, convinced that the reverse is the case, yet, although several competent clerks have presented themselves, the difficulty of procuring vacancies in the towns where the necessary conveniences and security could be found, has prevented them from receiving appointments. The telegraphers appear to have been at first trained in the large offices, but the practice has been discontinued at the two largest—Rosario and Panama—"on account of the many errors which were incurred in the retransmission of telegrams being chiefly committed by learners who were not sufficiently competent." They are now educated either at the school of instruction which has been instituted at Buenos Ayres, or they are placed at one of the minor stations in the interior.

A uniform tariff is adapted betwixt all the National Telegraph Offices, and is at present 25 cents

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* The hard dollar (peso fuerte) is worth about 4s. 2d., and should not be confounded with the paper dollar (moneda corriente) which is only worth 2d. The former is always used in national and the latter in provincial accounts.

(about 1s. 0½d.) for every ten words, not including the addresses and signature, which are sent free; each figure is counted as a word. For Press messages 25 cents are charged for the first twenty-five words, and 1 cent for each succeeding word. It is now proposed to abandon this tariff, and adopt in its place the system of the International Convention. Should this be carried out the minimum charge will then be 40 cents (about 1s. 8d.) for any number of words up to twenty, including the addresses and signature; 20 cents for every succeeding ten words; each group of figures up to five to be considered as one word.

During the first three years—1870, 1871, and 1872—the traffic went on rapidly increasing; but in 1873 there was a marked decrease in the number of messages, although the actual value was considerably over that of those dealt with in 1872.

The following returns show the progress of the telegraphs from the commencement:—

Year.	No. of Telegrams.	Value in Hard Dollars.	Total Cost of Maintenance.
1870	6,440	1,511·05	14.532
1871	61,429	32,490·78	81,361
1872	181,773	78,560·67	111,243
1873	170,823	81,827·80	193,870

This falling off is accounted for, first, by the destruction of the telegraph lines through inundations in the Northern provinces; and secondly, by the Rebellion which broke out, in the beginning of May, in the province of Entre Rios, and continued until the close of the year. The natural consequence was, that although the number and value of private messages decreased, yet those sent upon Government business were considerably in excess of the previous year. The following comparison of private telegrams with official during the years 1872 and 1873 is interesting:—

Year.				Value in Hard Dollars.
1872.	Private	...	166,802	64,458·56
„	Official	...	14,971	14,102·11
1873.	Private	...	150,424	57.760·41
„	Official	...	20,399	24.067·39

From the figures which are published above it will be seen that the receipts from private telegrams by no means cover the expense of maintaining the Service, and this it is which has mainly led to the contemplated revision of the tariff already alluded to.

An interesting section of the Report is occupied with a narrative of the difficulties which the Staff had to contend with during the year 1873; the Rebellion in Entre Rios "left behind it about 700 miles of line in the most deplorable condition." During the war, also, large sections of the wire were stolen, on account of its intrinsic value, by the neighbours to the line, and used for fences or other domestic purposes.

Great difficulty was experienced frequently in securing the delivery of telegrams to the National army. In one town, occupied by the rebels, a clerk resided in the Telegraph Office, and the other *employés* being prohibited entrance, a lady—who was made aware of the circumstances—entered the office, and, by secreting the telegrams in her dress, succeeded in delivering them.

The working of the lines is frequently interrupted by faults, in many instances ingeniously devised evidently by those acquainted with the science, in others apparently prompted by pure mischief. Upon one occasion, for instance, "a wire was totally disconnected betwixt Rosario and Cordoba. The linemen examined the section several times without succeeding in detecting the fault, until finally it was discovered that a portion of the wire had been cut out, and replaced by a curtain cord of the same gauge, and painted so as to resemble in appearance, as closely as possible, the line wire. Guitar-strings are frequently placed so as to connect the wires with the iron posts, at points where they can with difficulty be seen from the road. In one instance one of these guitar-strings had been employed to bring two wires, running upon the same line of poles, into contact with each other, and was then covered over with a piece of raw hide in such a manner that the linemen, knowing that the hide alone could not cause the fault, passed and repassed the place without suspecting what was wrong."

The assistance which the telegraphs of the Argentine Republic have rendered to the Government cannot well be over-estimated. Their value in stamping out rebellions, and preventing the needless effusion of blood, is acknowledged, and one may be permitted to indulge the hope that, when the enormous power which they wield comes to be more generally recognised, they will prove a still more valuable ally to the cause of order, and become one of the most powerful agents in effectually putting an end to the anarchy to which this vast and rich country has been so long a prey.

PRACTICAL BATTERY FORMULÆ.*

By EMILE LACOINE.

There are in use several formulæ to ascertain the number of elements necessary to obtain a determinate electric strength in the receiving apparatus of a telegraph line; but most of them are complicated, and are expressed in functions of the voltaic constants, which are not always exactly known for the batteries in use; moreover, the formulæ do not take into account the greater or lesser sensibility of the receiving instruments.

I propose to investigate not the number of elements necessary to determine a certain electric strength, but the number sufficient to work regularly a given apparatus, the resistance of the line to earth, and insulated, being alone known.

On a given line the instruments are ordinarily alike at the two extremities, but, as this statement may be objected to, let it be admitted that the two stations A and B are in communication, with the aid of any instruments whatever. To find out the number n of elements which should be placed in A to suit B's instrument:—First, let B work his own instrument on short circuit, commencing with one element, and increasing the number until the working is regular and sure. Call p that number, and r the resistance of the apparatus in question; then $\frac{p}{r}e$=strength of signal through B's instrument from p elements worked on short circuit, e being the electromotive force of each element of the battery employed. We will neglect the battery's resistance, which may usually be done without sensible errors, for all the investigations of telegraphic circuits. Secondly, connect B's apparatus to line, and designate by R the total resistance of the line and instrument. With n elements at A, the strength of the signal received from A at B will be $\frac{n}{\mathrm{R}} e$, not accounting for loss from the line itself. In this ideal case we may calculate the value of n from the two foregoing quantities, which by supposition equal each other. Thus—

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* Translated from a Paper communicated by the Author.

$$\frac{n e}{\mathrm{R}} = \frac{p e}{r}$$

$$n = \frac{p}{r} \mathrm{R} \quad . \quad . \quad . \quad (1)$$

This expression for n is only possible when the line suffers no loss, and is therefore the minimum of elements that can be suitable; but this number will never suffice in practice. One ought, however, to endeavour to approach the nearest possible to it, and it is by the comparison of those numbers which are found to be actually necessary with this number (equation) that we may judge of the state of the line.

It is therefore necessary to submit formula 1 to a correction. If on the line in question we are aware of the relation which exists between the strengths of a current at the "start" and "arrival," it will suffice to multiply the expression by that relation. Say that I is the strength of the starting current, and I′ that of the received current; then $\frac{\mathrm{I}}{\mathrm{I}'}$ is the multiplicand, and—

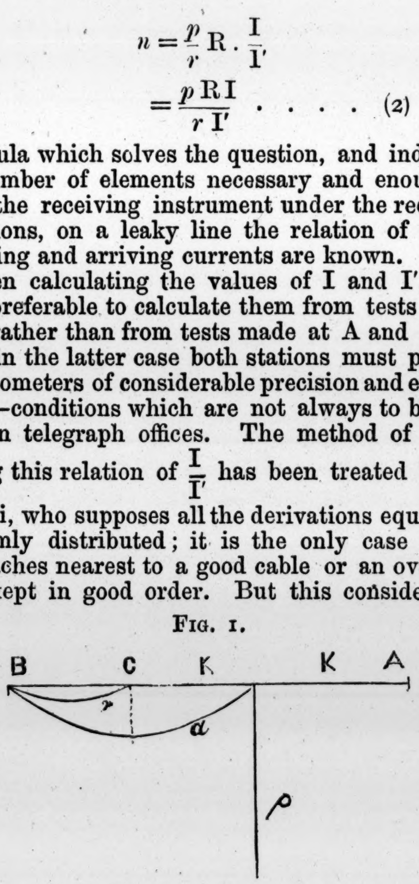
$$n = \frac{p}{r} \mathrm{R} \, . \, \frac{\mathrm{I}}{\mathrm{I}'}$$

$$= \frac{p \, \mathrm{R} \, \mathrm{I}}{r \, \mathrm{I}'} \quad . \quad . \quad . \quad . \quad (2)$$

a formula which solves the question, and indicates the number of elements necessary and enough to work the receiving instrument under the required conditions, on a leaky line the relation of whose departing and arriving currents are known.

When calculating the values of I and I′, it is more preferable to calculate them from tests made at A, rather than from tests made at A and B, because in the latter case both stations must possess galvanometers of considerable precision and exactly alike,—conditions which are not always to be met with in telegraph offices. The method of determining this relation of $\frac{\mathrm{I}}{\mathrm{I}'}$ has been treated by M. Calgari, who supposes all the derivations equal and uniformly distributed; it is the only case which approaches nearest to a good cable or an overland wire kept in good order. But this consideration leads one away into long complicated calculations, and, as we arrive at the same conclusions by supposing all the losses collected at the centre of the line, we shall base our calculations to determine the relation $\frac{\mathrm{I}}{\mathrm{I}'}$ upon this supposition.

FIG. 1.



Let A and B (Fig. 1) be the two stations, C the end of the line, B C or r equalling the resistance of the coils. K equals half the resistance of the line, and ρ is the sum of the leakages massed in the middle of the line: put down, for simplicity, $r + \mathrm{K} = a$.

According to the well-known laws of derived currents we shall have, in calling R as before, the resistance of the line including the coils,—

$$\mathrm{R} = \frac{a \rho + \mathrm{K}(\rho + a)}{\rho + a} \quad . \quad . \quad (3)$$

from which the strength of the departing current may then be represented by—

$$\mathrm{I} = \frac{m(\rho + a)}{a \rho + \mathrm{K}(\rho + a)},$$

m being a function of the electromotive force. The strength of the arriving current will be, according to the same laws,—

$$\mathrm{I}' = \frac{m(\rho + a)}{a \rho + \mathrm{K}(\rho + a)} \, . \, \frac{a \rho}{a + \rho} \, . \, \frac{1}{a} = \frac{m \rho}{a \rho + \mathrm{K}(\rho + a)},$$

from which we at last obtain—

$$\frac{\mathrm{I}}{\mathrm{I}'} = \frac{\rho + a}{\rho};$$

and, by replacing a by its value $r + \mathrm{K}$, it becomes—

$$\frac{\mathrm{I}}{\mathrm{I}'} = \frac{r + \mathrm{K} + \rho}{\rho} \quad . \quad . \quad . \quad (4)$$

It is now necessary to substitute the *known* values of K and ρ. Now, if we know i the resistance of the line insulated at C, and t its resistance to earth, also at C, we shall have, according to the same laws,—

$$i = \mathrm{K} + \rho$$

$$t = \frac{\mathrm{K} \rho + \mathrm{K}(\rho + \mathrm{K})}{\rho + \mathrm{K}},$$

from which we derive—

$$\rho = \sqrt{i(i - t)}$$

$$\mathrm{K} = i - \sqrt{i(i - t)},$$

substituting in (4) these values for K and ρ,—

$$\frac{\mathrm{I}}{\mathrm{I}'} = \frac{r + i}{\sqrt{i(i - t)}} \quad . \quad . \quad . \quad (5)$$

which is the same expression as that found by M. Calgari.

If in equation (2) we substitute for $\frac{\mathrm{I}}{\mathrm{I}'}$ this value we have—

$$n = \frac{p}{r} \, . \, \frac{\mathrm{R}(r + i)}{\sqrt{i(i - t)}} \quad . \quad . \quad (6)$$

We may also still further simplify this expression by noting that R is a function of r, i, and t. Take equation (3), and replace a, ρ, and K by their values in functions of r, i, and t; then we have—

$$\mathrm{R} = \frac{i(r + t)}{r + i},$$

which renders equation (6)—

$$n = \frac{p}{r} \quad \frac{(r + t}{\sqrt{} \, (i -} \quad . \quad (7)$$

the final, sought-for expression. The quantities i and t are given by the periodic line tests; r is equally known, as also is p.

This value of n gives, then, the quantity of elements really necessary and enough to work the instrument r with the same regularity at the extremity of a line as if it worked it on short circuit with p elements.

On cables, $r = t$ almost always; for the same instrument is designed to always work on the same cable. In that particular case the expression is still further simplified, for it becomes—

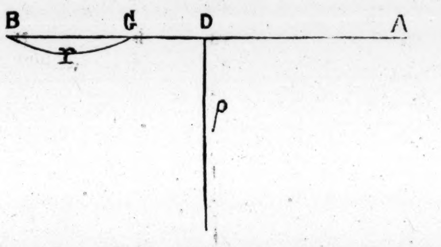
$$n = \frac{2pi}{\sqrt{i}\,(i-t)} \quad . \; . \; . \quad (8)$$

When these formulæ are applied to practice, the values given to n are often noticed to be too small. That is especially remarked when there are accidental losses of the current found to exist, more particularly on overground wires. This apparent deviation may be explained and remedied.

Indeed, until now, we have supposed all the losses massed in the middle of the line, which presupposes there are no accidental leakages. But if there are regular losses they will be so much the more hurtful as they are nearer the centre, not of the line, but of the circuit.

If we resume all our calculations with this last hypothesis of the losses massed in the middle of the *circuit*, as it is the most unfavourable case that can happen, we shall then certainly have a number for n which will be always enough. We find in this case, where B D = D A, that the portion of the line $\mathrm{CD} = \mathrm{K} - \frac{r}{2}$, and that $\mathrm{DA} = \mathrm{K} + \frac{r}{2}$, when K is still called the resistance of half the line.

FIG. 2.



Following similar courses of reasoning to those of the former calculations, we have—

$$n = \frac{p}{r} \cdot \frac{(i - \sqrt{(i-r)(i-t)}\;(i + \sqrt{(i-r)(i-t)})}{\sqrt{(i-r)(i-t)}}$$

Then if we make $\sqrt{(i-r)(i-t)} = b$, we find—

$$n = \frac{p}{r} \cdot \frac{(i-b)(i+b)}{b} \quad . \; . \; . \quad (9)$$

This formula, although more complicated in appearance, can be reckoned as quickly as the others. With logarithms the conversion of these formulæ into numbers requires less time than even the test of the line.

Formula (9) is that which should be made use of on overland wires, so as to be sure not to calculate for too weak a battery; whilst (7) or (8) should be used for cables which suffer no abnormal wastes. Thus, for example, according to my own experience, I find for a Morse receiver, having a mean resistance of 1600 Siemens' units, the relation $\frac{p}{r}$ equals $\frac{1}{400}$, for four of Daniell's elements suffice: then n will be expressed in Daniell's elements. For Hughes's apparatus, of 1200 Siemens' units, two Leclanché's elements are enough; we have then $\frac{p}{r} = \frac{1}{600}$, and n is thus expressed in Leclanché's elements.

To conclude with a particular application of formula (9). I find in my notes, for a line of 1200 kilos. in length and 5 m.m. diameter, with a Morse apparatus of 1600 Siemens' units (we have admitted $p = 4$), that—

$$i = 6200,$$
$$t = 6000.$$

This line was bad, and the test had been made with precision, because with a battery of 100 Daniell's elements it could not be suitably worked: the formula shows that about 130 elements were necessary. This same line, when put into good condition, gave—

$$i = 38000,$$
$$t = 6500,$$

and was being worked with 60 Daniell's, whilst the formula showed that 22 would have been enough.

It is seen by this example what numbers of elements to employ upon the same line in its different phases of insulation; and we have therefore no longer any excuse to keep in use, as is often done, a greater number of elements than is necessary to work the line.

ON THE ELECTROMOTIVE FORCE OF PALLADIUM IN GAS-BATTERIES.

It was demonstrated by Graham, in one of his latest researches, that palladium has a powerful attractive force towards hydrogen, so that it can condense, in its pores, more than 900 times its own volume of that gas; and further, that the hydrogen thus condensed and combined had a remarkable power of deoxidation, so that it reduces salts of oxide of iron to protoxide salts, and changes red ferrocyanide of potassium into yellow. He conceived hydrogenium (the hydrogen thus combined and condensed) as the active form of that gas, as ozone is of oxygen.

From researches (especially those of Bœtz) on the electromotive force of gas-batteries, it appears that this force depends not only on the opposite affinities of the constituent gases, but also on the power of condensation of the solid bodies forming the electrodes. To this is owing the high electromotive force of a gas-battery with platinum electrodes.

From these data Prof. Villari, of Bologna, was led to anticipate that a gas-battery with palladium electrodes would present a still greater electromotive force than one with platinum electrodes; and his experiments have verified this.

He first tried to compare directly the electromotive force of two gas elements,—one with platinum, the other with palladium electrodes; but secondary actions proved so disturbing that he was forced to reduce the phenomenon to its most simple forms, and then study it. He thus examined, first, the comparative action of platinum and palladium in hydrogen gas; then he compared the action of platinum and palladium in oxygen; and then the action of two gas-batteries.

In reference to the first point it appeared, from repeated experiments (in which two electrodes, platinum and palladium, were immersed in hydrogen), that the palladium was the negative or more readily oxidisable element; and as the two well-polished metals were almost equally unattackable by acidulated water, we must suppose that it is the hydrogen which, in contact with palladium, is more oxidisable than in combination with platinum. This quite agrees with the ideas of Graham. To obtain such experimental results the palladium must be exposed a considerable time to the hydrogen, whether chemically or physically (electrolytically) produced; otherwise very small, and even opposite, deflections may be had, especially with chemically prepared hydrogen. In fact, immediately after contact of the hydrogen with the two electrodes, the hydrogen in contact with the platinum seems the most readily oxidised. This anomaly disappears, however, in a short time, which, in the author's experiments, never exceeded thirty minutes.

It need hardly be said that whenever the palladium is once charged with hydrogen, it is not necessary to prolong the contact of these bodies if they are again to be experimented with, and one may thus, without waiting, change or renew the hydrogen at will. The palladium, so charged, may act for a long time as if it were in contact with hydrogen, and appear as oxidisable element, even if quite immersed in acidulated water. To make the foregoing investigation, then, it is necessary to dehydrogenise the palladium, which can be done in several ways.

The action of oxygen in gas-batteries with platinum electrodes is very complicated. Prof. Villari commenced by taking two ordinary glass tubes,—one containing a platinum, the other a palladium plate, both metals well polished,—and giving no current in the galvanometer, when the tubes were filled with acidulated water. He next half-filled both tubes with chemically prepared oxygen, and observed that, after a long time, the galvanometer still remained at zero; whence must be inferred either that the metals had no particular influence on the oxygen, affecting its action in any way, or that the influence in both was the same. To decide this he took two polished platinum wires, which, immersed in acidulated water, gave no current; he then filled one of the two tubes with chemically prepared oxygen, and kept the other filled with acidulated water; a slight deflection appeared, which quickly decreased to *nil*, the platinum covered with oxygen acting some time as electro-positive element. It is therefore clear that an action of this kind, perfectly negligeable, is also to be attributed to the palladium plate covered with oxygen; and it may therefore be affirmed that these metals have no special influence on this gas. This agrees with the already known fact that neither platinum nor palladium absorb any oxygen when serving in a voltameter as positive electrode.

The action of oxygen is, on the other hand, very lively when it is obtained electrolytically, for in this case it is mixed with a certain quantity of ozone. M. Villari, using two platinum electrodes, observed that the one dipped in ozonised oxygen was strongly electro-positive towards the one in chemically prepared oxygen. With palladium electrodes the phenomena is still more complicated, for, besides the ozone from the chemical decomposition of water, the palladium acting in a voltameter as positive electrode becomes coated with a dark red layer of oxide of palladium. This oxide is soon dissolved in unacidulated water, and in a short time the metal takes its original properties; it behaves, further, as a strongly oxidising body.

All the observations, including that of the time required for charging of the palladium with hydrogen, fully explain the differences obtained in the first direct comparative experiments with platinum and palladium batteries.

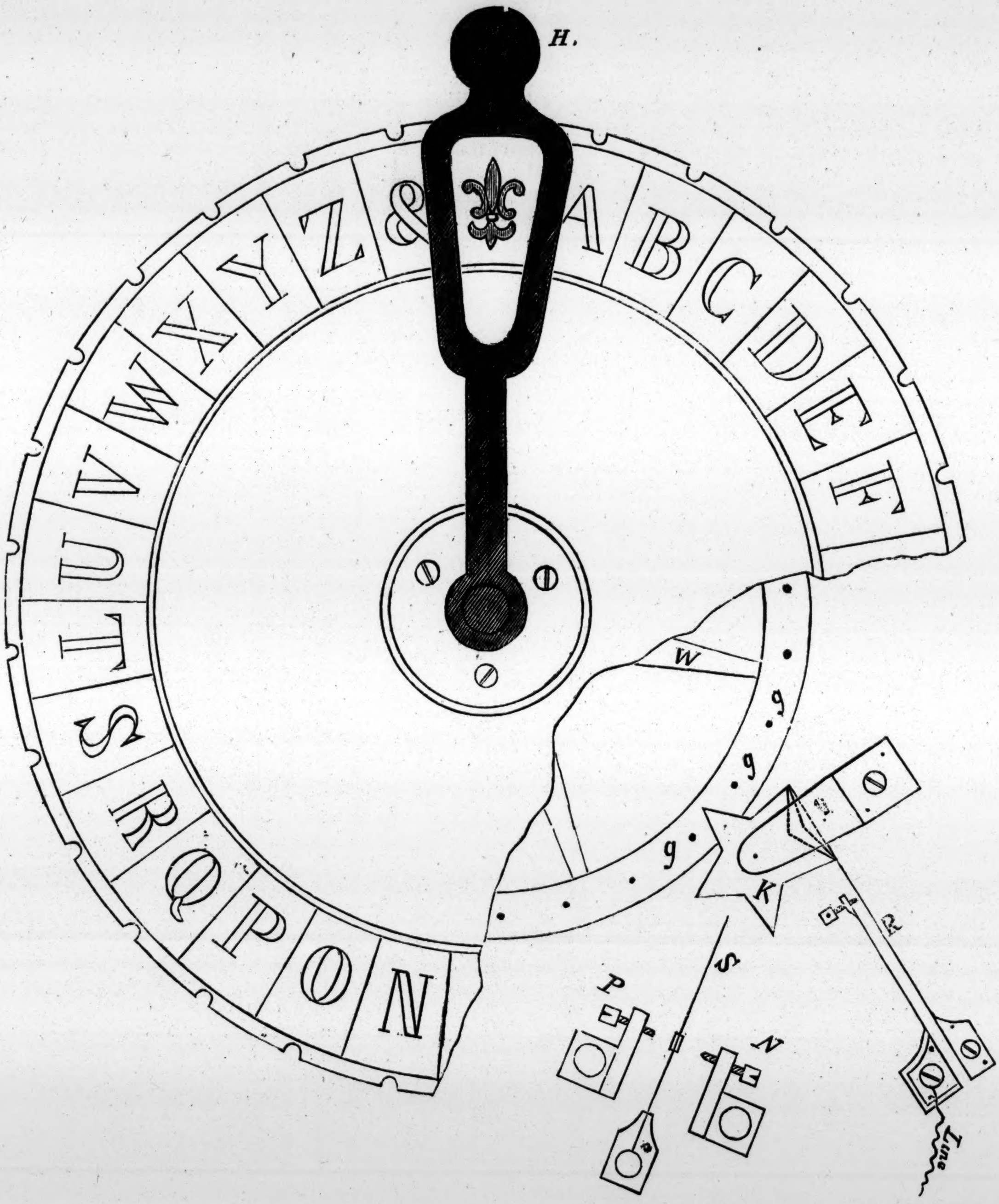
Profiting by the information now acquired, Prof. Villari proceeded to a comparison of the batteries. He charged, in the proper way, a platinum and a palladium electrode with chemically prepared hydrogen, and half an hour after they gave, in the galvanometer, a constant deflection of 60° to 70°, the palladium appearing electro-negative. He also charged two similar electrodes with chemically prepared hydrogen, and they gave no current in the galvanometer. He then formed with these elements two gas-batteries,—the one with platinum, the other with palladium electrodes.—put them in opposing action, and closed the circuit with the galvanometer, which gave an initial deflection of 90°, sinking—with oscillation—to 20° or 30°, later to 10° or 20°, and after some time to zero. The deflections indicated a superiority of the palladium battery. As soon as the galvanometric deflection had sunk only a few degrees, the author compared anew, by means of the galvanometer, the platinum and palladium in contact with hydrogen, and obtained a constant deflection of 60° to 70°, exactly as before this experiment; so that the negative electrodes had not, during this process, lost their action. He compared again the two platinum and palladium electrodes covered with oxygen, which at first, as stated, gave no deflection; and remarked that the latter gave a strong deflection of 50° to 60°, the palladium appearing as the attackable element of the combination.

This observation, repeatedly confirmed, is an indication (M. Villari says) of a secondary polarity appearing in the action of the battery with palladium electrodes, and which weakens its intensity till it is nearly equal to that of the platinum electrode. A similar phenomenon occurs with the platinum, so that the platinum cannot be used as positive electrode of the palladium battery. Further, if as soon as the galvanometer connected with the opposing batteries has been deflected only a few degrees, we close one of the circuits for a few minutes with a short copper wire, it is found, on removal of this, that the action of the other battery preponderates, on account of the ordinary secondary actions which weaken more the battery closed with the short wire than that closed with the long galvanometric coil. Analogous observations and comparisons were made on batteries charged with electrolytic hydrogen and with chemically prepared oxygen; and similar results were had, though perhaps less marked than the above, corresponding to the less electro-chemical difference between platinum and hydrogenised palladium.

Lastly, Prof. Villari compared two batteries together, which were charged with hydrogen and oxygen developed electrolyically thirty to forty minutes on each of the platinum and palladium electrodes; and when both were connected with the galvanometer, they gave a first deflection of 90°, and a constant one of 50° to 60°,—in consequence, again, of the superior electromotive force of the palladium battery. It is to be noticed in this case, however, that the palladium—which acted as positive electrode—got covered with a dark red layer of oxide of palladium, which evidently increased the action of the battery: an action which, after consumption of the oxide, greatly diminishes, so that after some hours the intensities of the currents of both gas-batteries almost perfectly compensate each other.

These, then, are the actions which occur in a gas element with palladium electrodes. It is fully ascertained, from experiment, that such an element possesses a greater electromotive force than a Grove element, as the hydrogen brought in contact with the palladium (*i.e.* the negative electrode) is much more readily oxidisable than the hydrogen in contact with the platinum. This electromotive force increases yet more if the palladium which is in contact with oxygen (*i.e.* the positive electrode) is oxidised, because it acts then as a very oxidisable body.

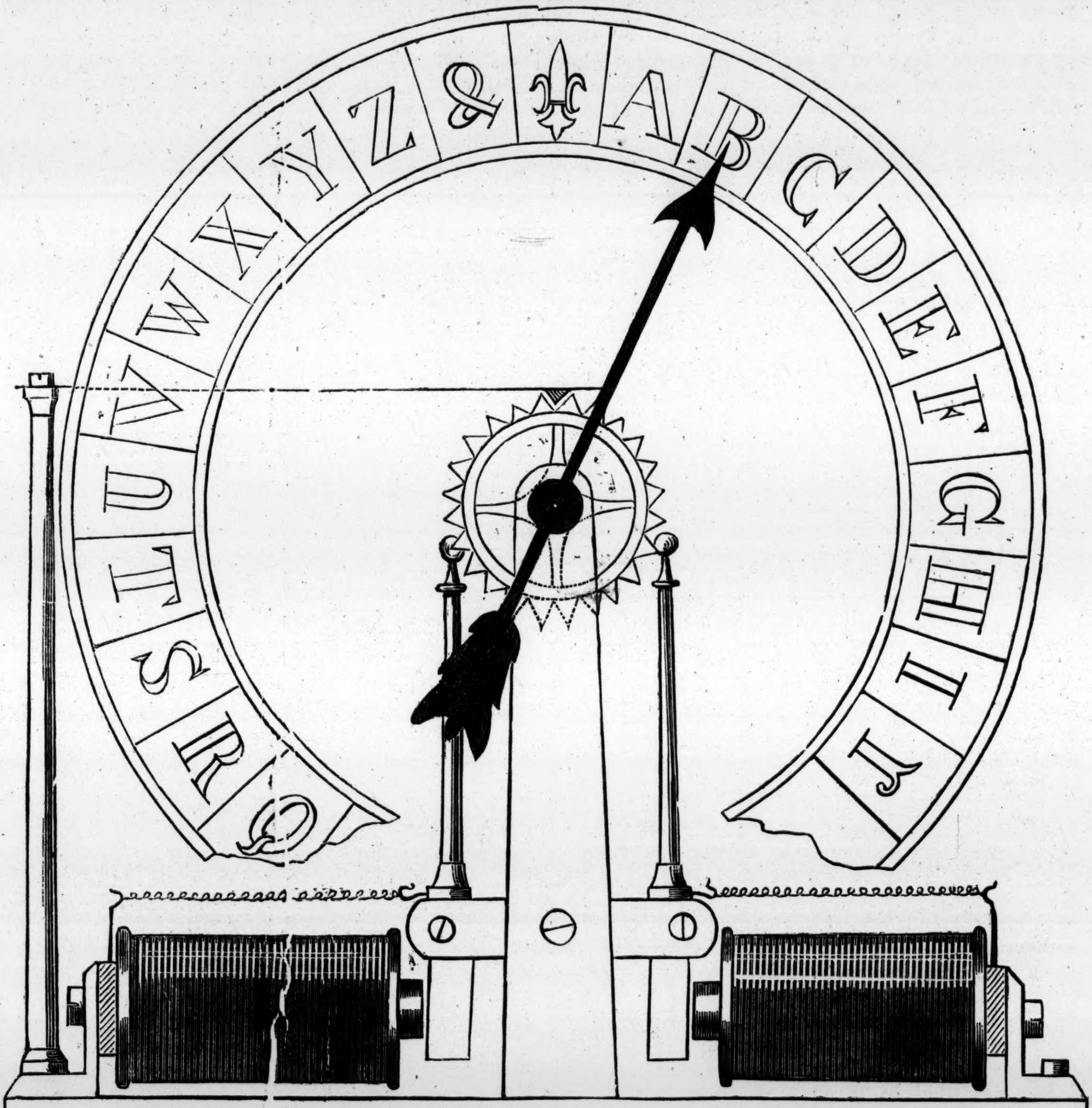
FIG. 1.



ON A NEW STEP-BY-STEP INSTRUMENT, OR ALPHABETICAL TELEGRAPH.

MR. S. M. YEATES, the excellent philosophical instrument maker, in Dublin, has invented a most important modification of the step by step telegraph. In all alphabetical telegraphs hitherto made it is essential that the operator should always move the handle round in one forward direction, and therefore, if a letter be required which precedes the one last indicated, it is necessary to carry the pointer all the way round the dial in order to indicate the letter required: if, for instance, the word "day" be transmitted, the operator moves the index from zero to D, passing over A, B, and C: having thus passed A, it becomes necessary to go all round the dial to arrive at A, and having passed Y must again go round the whole alphabet before the word is completed. As each letter passed by the transmitting instrument sends a current which actuates the receiving instrument, and makes its index perform the same motion, it follows that, in transmitting this little word "day," there are no less than 49 currents sent along the line, and, as any one of such currents may miss, there are 49 chances of the instrument "tripping," as it is called.

Fig. 2.



In Mr. Yeates's new instrument both the transmitting and receiving instruments work backwards or forward indifferently, and therefore—in the case supposed of the word "day"—the operator, having moved the index to D, has only to move it back to A, and then back to Y, thus transmitting the word with only eleven contacts, instead of forty-nine as in the other case. The great advantage gained by this will at once be seen:—First, it greatly increases the speed of the instrument; and secondly, it greatly lessens the chances of tripping.

The action of both the receiving and transmitting instruments will be best understood by reference to the cuts. Fig. I is the transmitter, part of the dial being removed in order to show the arrangement of contact. Suppose the handle, H, to be moved towards the letter A, it carries with it the wheel W, and the pins, *g g g*, in its edge come in contact with the wheel K, and, moving it round, causing one of its teeth to press against the spring S, and form contact with the stud N, thus closing the circuit, and sending out a *negative* current which passes through the right-hand magnet of Fig. 2 (the receiving instrument), and causes its index to move towards A also. A similar action takes place when the handle is moved in the opposite direction; only in this case the spring S is pressed against the stud P, thus sending a *positive* current, which passes round the left-hand magnet of the receiver, and thus makes the index move towards Z on its dial.

It will be observed that when the handle of the transmitter is on a letter the spur-wheel K has one of its teeth midway between two of the pins, *g g*, in W; it is kept in that position by the spring R. The action of R is as follows:—When the pin *g*, pressing against the tooth of K, causes this wheel to turn round until one of its teeth, sliding along one of the inclines of R, arrives at the point where the two inclines meet; then the spring comes into full play on the opposite side of the tooth, and carries K the remainder of the way, so that the pins in W only move K half of a tooth, and R moves it the other half, and it is while it is passing through the second half-tooth that contact is made between the spring S and the studs P or N. In this way it is not possible for the operator to make a false contact, or cause the index of the receiver to move while hesitating between two letters, as would occur in any other form of alphabetical telegraph.

A few common-place words in daily use will illustrate the saving effected in time and in consumption of battery by this arrangement:—

Briguet's Instrument.			Yeates's Instrument.		
Day ...	49	currents	Day ...	11	currents
Weather	131	„	Weather	56	„
To ...	42	„	To ...	12	„
And ...	31	„	And ...	24	„
From ...	72	„	From ...	29	„
The ...	59	„	The ...	22	„
	384			154	

Or 64 to $25\frac{1}{6}$.

One of the most obvious advantages of this simple and excellent arrangement is, that it can be used by the public without any preliminary instruction. Even in the ordinary step-by-step instrument, simple as it is, a wholly inexperienced operator constantly forgets he must always go forward to reach the letter he wants; and besides the time and battery power consumed, there is a mental worry or consumption of nervous power in finding that when you send the word "cat," for instance, you must go all round for A after C has been transmitted. As one instinctively tries to go to work in the quickest way, it is provoking to find a letter so near, and yet have to go so far to reach it. In Mr. Yeates's new instrument, instead of being thus disagreeably tantalised, one can do just as one pleases—and this is always pleasant.

We are glad to bring this useful instrument before our readers, and, having seen it in rapid operation, can heartily commend it.

ON THE CONDUCTIVITY OF MERCURY VAPOUR FOR GALVANIC CURRENTS.

GASEOUS bodies, it is known, are conductors only in connection with flame, or, in general, at the temperatures which occur in flames. It is also known how much the conductivity of flame increases when metallic vapours are introduced into it. The question naturally occurs,—How would a gaseous layer exclusively formed of such vapours behave? Would it not show conduction even at low temperatures? This forms the subject of a research recently described by M. Hermann Herwig, in *Poggendorff's Annalen.*

Mercury was peculiarly suitable for the purpose, inasmuch as, by simple boiling, dense vapours of the metal can be had with a temperature several hundred degrees under white heat.

As to the author's mode of experiment, we shall merely remark that, by suitable arrangement and heating of horizontal tubes containing some mercury, a pretty constant layer of mercury vapour was produced between two mercury surfaces. The heating was at the middle, and the electrodes were inserted at the ends, of the tube, in a particular way which M. Herwig describes.

M. Herwig considered very carefully the conduction produced in glass when heated, and allowed for this in interpreting the numerical results for conduction by vapour.

In discussing these results he points out, as the most important fact about the vapour conduction, that it is not like that of a simple metallic conductor, but resembles that of a voltaic arc. There appears to be a peculiar transition-resistance (*Uebergangs widerstand*), for the current passing into the vapour layer. This is great compared with the hindrances presented to the passage of the current within the layer itself, so that (in general) the entire resistance is independent of the extent of the vapour layer. The transition-resistance, again, becomes smaller with increasing electromotive force of the battery, or increasing strength of current. In both these points there is a perfect analogy to the phenomena of the voltaic arc.

In the voltaic arc the pulverisation of the electrodes is an essential factor. If something similar occur in the phenomena under consideration, it will appear in influence of the current on vaporisation. M. Herwig made observations on this point, and an action of the kind was readily apparent. Having produced a regularity of boiling on the mercury surfaces, he closed the circuit, and then perceived a continuous, lively, tremulous motion of the mercury surface, and abundant formation of new vapour bubbles between it and the glass wall, in that half of the tube which led to the *positive* pole. The other mercury surface showed nothing of the kind.

If we compare, with these, the observations of Tystov and Van der Willingen, according to which a mercury surface, used as positive electrode, in the voltaic arc, opposite a negative platinum wire, shows vigorous vaporisation, while with the current sent the opposite way it shows none, the analogy is obvious. We have thus, M. Herwig remarks, a kind of incipient and obscure voltaic arc, which is formed at temperatures of about 300° C., and which may be maintained or brought into action by a small electromotive force, *e.g.*, a Grove element.

To test the correspondence further, M. Herwig next considered the fact that, in a voltaic arc with the electrodes just mentioned, the resistance of the arc is smaller if the mercury surface is positive. He experimented specially with the mercury vapour in reference to this; fixing a platinum point in the vapour above the mercury heated in a tube; getting two such apparatuses, alike and equally heated, and sending the same current in opposite directions in the two. The action each time was much greater in the tube in which the mercury substance was positive, thus showing another point of agreement with the voltaic arc. And this behaviour, moreover, was observed to be independent of the density of the vapour.

According to M. Edlund, the pulverisation in the voltaic arc gives rise to an electromotive opposing force which accounts for the characteristic properties of the arc. In M. Herwig's experiments this would correspond to the action of vaporisation; and the author enquired, experimentally, as to what would occur if the vaporising action of the current were prevented. He failed to find a corresponding action here, and is led to doubt whether Edlund's explanation of the phenomena in the voltaic arc be the correct one.

Among other results obtained in the experiments it was found that with increasing pressure the conduction increased more than the pressure, indicating the influence of temperature. Vapour does not conduct like an ordinary metallic conductor. In a metallic conductor, if it is solid or liquid, the temperature acts (it is known) in the opposite direction on the conductivity, the action, however, it is to be noted, being less on metals in the liquid than in the solid state. In metals having the form of vapour the influence of temperature is in the same direction as in electrolytes.

Lastly, to give some idea of the amount of resistance in mercury vapour, M. Herwig states that the vapour at about 400° C. (the most favourable of the temperatures produced), in a tube of 4 m.m. clear diameter, gave a resistance of about 50,000 Siemens units.

THE RIVER PLATE CABLE.

On the 15th of August the inauguration of the cable to Buenos Ayres was officially celebrated by the Argentine Government. On this occasion the following excellent speech was delivered by President Sarmiento:

"We this day attend an inauguration which, were the earth and water alive to feeling, they would undergo sentiments of the greatest emotion, flying upon the wings of electricity.

"We, who have been born in the present age, may consider ourselves blessed by the prodigies which from its commencement have been almost daily realised; and history appears to mark out in slow and solemn steps the glorious future presented to our view. Four ages ago three miserable ships, three schooners, three lighters, as classified under the present nomenclature of vessels, which now embrace clippers, ironclad vessels, and ships of 5000 tons, crossed with fear and trembling the profound ocean which separates us from the old world. At the commencement of the present century, a Spanish ship was the bearer of news from Europe of twelve months' previous date, communicating that the then king of this country, Fernando VII., was the captive of Napoleon. America became independent as soon as it was aware that it had no longer a monarch, and was exposed to be delivered over to another crowned head.

"Thirty years ago the learned Andres Bello, a native of Venezuela, established in Chili, awaited an answer to letters addressed to the correspondents of his own country three years previously.

"I was present at the inauguration of the first submarine cable of the United States, and heard Mr. Field, its indefatigable promoter, give a vivid account of the difficulties he had undergone, of the triumph he had obtained in uniting the Northern Continent of the Atlantic Ocean with Europe.

"I have this day the pleasure to open the communication of that country which gave me birth to that of the civilised orb, and have to thank Providence which has vouchsafed me so great a blessing."

Two days after this the election of the next President took place, and it is interesting to note how rapidly the news was transmitted throughout the far interior of the Argentine Republic.

The proclamation of the election of the new President, Dr. D. Nicolas Avellaneda, was forwarded by telegraph from Buenos Ayres at 5 P.M. to the governors of the different provinces, and was received at the respective capitals at the hour stated below:—

Cordoba	436	miles	at	5	P.M.
Santiago	728	,,	,,	5.10	,,
Tucuman	822	,,	,,	5.8	,,
Salta	1026	,,	,,	5.11	,,
Jujuy	1077	,,	,,	5.20	,,
Catarmarca	962	,,	,,	5.9	,,
Rioja	1058	,,	,,	8	,,
Corrientes	658	,,	,,	9.0	,,
Santa Fé	288	,,	,,	5.40	,,
Conception	548	,,	,,	5.55	,,
San Luis	578	,,	,,	5.50	,,
Mendoza	739	,,	,,	5.53	,,
San Juan	842	,,	,,	5.55	,,

If our readers will turn to a map of South America, they will see how widely scattered are these places, and yet into these remote regions the telegraph has made its way. Experience is teaching us that the telegraph, before all things, is becoming the herald of civilization, and, let us hope, the key to the future solidarity of the world.

Students' Column.

PAPERS FOR JUNIOR STUDENTS.

By ARTHUR R. GRANVILLE.

(Concluded from p. 231.)

VII. *Speed of Signalling.*—The student, if he has carefully read my previous papers V. and VI., will be in a position to investigate the formulæ bearing upon "Speed of Signalling," and, of course, its necessary accompaniment, "Rate of Working," on cables, since these formulæ are dependent on the relative diameters of dielectric and conductor.

The *signalling* formula is the same as the *working* formula, with the exception that the latter is affected with a variable constant according to the nature of the instrument worked. I therefore propose—first, to consider the conditions under which a charge sent into a cable makes itself manifest at the far end, which may be called signalling; secondly, how the constant coefficient is obtained, and the place it occupies in the formula.

The student must call to mind what happens when a quantity of electricity is launched into the cable. He must diabuse his mind of the idea that when a line wire is put to the positive pole of a battery the current instantaneously (without the slightest interval of time) appears at the other end in all the vigour and strength which it had at the first. This idea is not an uncommon one. Unless guarded against it is apt to mislead young beginners, and is a fault easily fallen into—owing to the rapid speed of a current through a good conductor—from students often failing to enquire what the velocity of a current really means.

The velocity of a current is not like that of a cannon-ball, or of any other body propelled by the exertion of a powerful and sudden force. The whole mass of such a projected substance possesses an equal velocity, and each particle impacts the object struck at the same time "*en masse*." A current obtains a different kind of velocity, for when a charge x traverses a cable an infinitesimal quantity y first appears at the distant station. That quantity goes on increasing to y', y'', y''', ... y^n, when it stops, but never reaches the full strength of the battery charge, y^n being less than x. From y' to y^n we may therefore have as many velocities as we choose; in other words, for the quantity y' of electricity to traverse a definite course, we shall have always a fixed velocity or interval of time,—assuming in this and all other statements that the conditions affecting the cable are ever the same. For a larger quantity y' of the same charge to pass through the same cable, we shall therefore have a slower velocity, and so on until y^n is reached when we shall have the slowest velocity of current possible in the experimented cable.

The progress of a current, and its accumulation at the terminus, may be likened to a wave in form. The first manifested effects may be termed the foot of the wave, whilst the maxima effects represent its summit. During the transit of the current from end to end a certain interval of time takes place. which is appreciable according to the length of conductor. This interval is longer in cables than in land wires, length for length, by reason of the retarding effects of induction and electrification. That a time-interval must take place is evident if we remember a current is the translation—in what way is immaterial to the present discussion—of a subtle force from place to place. For circuits of short lengths this interval is so minute as to become inappreciable. In fact, it is a fraction respecting which the mind can form no apprehension; much less can it be recorded by instruments of the most delicate sensibility. But, as I stated just now, the reverse is the case when dealing with submarine lines, and also with very long overland wires; in these the time intervals are larger fractions: in both instances this is owing to the retarding effects of induction, the effect being intensified in cables from the phenomenon of electrification. To illustrate by an example, I quote the following from Prof. Fleeming Jenkin's admirable work,* p. 328:—"For about two-tenths of a second after contact is made in England, no effect can be detected in Newfoundland, even by the most delicate instrument: after 0·4″ the received current is about 7 per cent of the maximum permanent current which will ultimately flow equally through all parts of the circuit. The current will gradually increase until, 1″ after the first contact was made, the current will have reached about half its final strength, and after about 3″ it will have attained nearly its maximum strength. During the whole time the maximum current is flowing into the cable at the sending end."

Now, in cables of different structure, what are the conditions which affect the velocity of a current? Upon these conditions, of course, depends the velocity or speed with which a current of any required strength accumulates at the receiving station sufficient to work the recording instrument; and according to the inertia of the instrument—or, more commonly speaking, its sensibility—so will be the relative rate of working with it as compared with another of greater or lesser sensibility. The inertia of an instrument is overcome by the *strength* of the current, and strength of a current—as students must know—signifies *quantity of electricity*, and the facility with which a stated quantity of electricity will arrive at a certain place is *directly* according to the resistance of the conductor: the resistance, R, thus forms one of the terms of the formula in question. The capacity, C, of the cable or overland wire, likewise constitutes another of the required terms; for according to the electrostatic capacity of the dielectric, which is entirely the result of the earth's inductive action and electrification, so will the velocity be affected in a *direct* ratio. Each of these quantities are INCREASED *directly* according to the lengths of the cable, and therefore the square of the length, L^2, supplies the third term of thr formula.

Together they become $RL \times CL = RCL^2$. These quantities are themselves prefixed by a constant dependent on the nature of the cable's material, and the inertia of the instrument used to record the faintest effect; from which the equation gives the results named in the extract from Prof. Jenkin's work. When cables are exactly similar in construction and material the time-interval of first electrical manifestation will be in proportion to the squares of their lengths.

When we deal with the question of *rate of working* the same quantities are used, but in an *inverse* proportion instead of *directly*. This is apparent on considering that the proportion is direct as regards the time-interval, because the greater the one the greater the other; but with respect to working an instrument, the *greater* those quantities $c\,r\,l^2$ the *less* the speed. Therefore the formula becomes—

$$S = \frac{c\,a}{C\,R\,L^2} \quad . \quad . \quad . \quad (1)$$

$c\,a$ being a variable constant, and S the working rate. This may be aptly termed the "Electrical Test Formula," since the quantities R C are supplied by electrical tests. There is also another, that may in a similar manner be called the "Constructing and Estimating Formula," because it is built up from the pre-determined dimensions of the cable, and because from it the *estimated* speed is calculated.

The working speed of the projected cable is based on the fact that the resistance and the electro-static capacity of any cable are respectively as the square of the diameter of the conductor, and the ratio of the diameters of dielectric and conductor; but the speed will be directly as these latter quantities, whilst it will still be inversely as the square of the length. The "Constructing Formula" is then—

$$S = c\,\frac{d^2 \log \frac{D}{d}}{l^2} \quad . \quad . \quad (2)$$

From equation (2) we may obtain the value of a in the empiric constant $c\,a$ in equation (1). Quoting from Mr. Clark's "Electrical Tables" (p. 74), for the benefit of those students who do not possess the work,—

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* "Electricity and Magnetism."

$$d^2 = \frac{81361}{R}, \text{ and } \log\frac{D}{d} = \frac{0{\cdot}18769}{C}$$

$$\therefore S = c\,\frac{81361}{R}\cdot\frac{0{\cdot}18769}{C}\cdot\frac{1}{L^2}$$

$$= c\cdot\frac{15270}{RCL^2}\quad .\;.\;.\quad (3)$$

in which 15270 is a of the constant $c\,a$, equation (1). Again, the remainder of this constant c may be determined from the RCL² of any cable, provided the speed of that cable is known. For—

$$c = S\,\frac{RCL^2}{15270}\quad .\;.\;.\quad (4)$$

and therefore equation (3) becomes—

$$S = \left(S\,\frac{RCL^2}{15270}\right)\cdot\frac{15270}{RCL^2}\quad .\;.\;.\quad (5)$$

in which the first term, in brackets, of the right-hand member, is the value of c.

It must not be forgotten that the constants vary with the nature of the instrument used, that for a Thomson's recorder being different from his mirror or the Morse.

Lastly, as regards the retarding effect of electrification on signals, referred to in paper V., Sir W. Thomson says—"It is easy to understand why there should be a particular diameter of copper which will give a maximum rate of signalling with a stated outer diameter of gutta-percha, since if the copper wire is too small there is a loss of speed, owing to a too large resistance not compensated by the smallness of the electro-static capacity; while on the other hand, if the diameter of the conductor be too large,—as, for instance, if it fall but little short of the outer diameter of the gutta-percha,—the thinness of the gutta percha coat gives rise to a greater loss of speed by increased capacity than is compensated by the gain owing to diminished resistance."

Electrical Science in English and Foreign Journals.

In addition to our usual abstracts, there will be found under this heading the titles of papers on electrical science which have appeared in English and foreign journals from the commencement of the present century up to the date of the establishment of this journal).

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxix., No. 11. September 14, 1874.

Further Conditions for the Production of Electric Effluvia; their influence on Chemical Reaction.—By M. A. Boillot.—In continuing my researches on the nature of ozone, and on the reactions produced by the electric effluvia (See TELEGRAPHIC JOURNAL, vol. i., pages 117 and 160), by means of the apparatus already described, I was led to try the following experiment: Instead of forcing the gas to pass between tubes forming a very narrow cylindrical annular space to be traversed by the *effluvia*, I wished to see the result of experimenting in a much larger space with the same electric source. To that end, I took a glass tube 36 centimetres long and 1 milimetre in interior diameter, and filled it with finely-powdered graphite. One of the extremities was closed hermetically by a lamp, and to the other was sealed a platinum wire communicating with the carbon inside. This small tube was centred in another of medium size, 9 millimetres in interior diameter, so that the two tubes were separated by about at least 3 milimetres. In this space the gases were submitted to the action of the electricity. These two tubes were placed in a third *large* one of same length as the small one, and the space between the two first and the third was also filled with powdered graphite. The two carbon rings formed at the ends of the third tube were closed up with gum-lac, care being taken to attach a platinum wire to the graphite in the large tube at the opposite end to the wire of the small tube. The gas when introduced was submitted to the action of electricity by connecting the two platinum wires with the electrodes of an induction coil, worked by from two to five Bunsen's elements of moderate dimensions. Under these conditions, and under the influence of a tolerably weak electric tension, the results were the same as with my other early apparatus. I first worked with atmospheric air, and afterwards with oxygen; in both instances ozone was obtained in proportions equal to my previously detailed experiments. The conclusion to be deduced is that the explosive spaces necessary to the production of the effluvia may be much extended, without the chemical action they determine being weakened. These experiments are being continued.

No. 12. September 21, 1874.

Void of electrical news.

Bulletin du Musée de l'Industrie de Belgique. September, 1874.

Has no papers on electricity.

Bulletin de la Socite d'Encouragement pour l'Industrie Nationale. October, 1874.

Apparatus used to Light the Chandeliers of the Paris National Assembly Hall.—By M. Gaiffe.—This is a description of the apparatus referred to in our first volume, page 338. The hall is lighted by means of chandeliers containing 256 burners. To each chandelier a wire conducts the electric charge, but the return currents traverse a single cable to which all the wires converge. Each wire at the battery end—or rather induction coil end—starts from a separate insulated metallic button, which are put in communication with the secondary wire of the coil by means of an excitor terminated by a ball, and attached to the coil by a chain; the other end of the coil's secondary wire is in connection with the return cable. The wire starts from the button and terminates at the burner; it resumes its course onward to the return cable, the circuit being complete, with the exception of a small breakage at each burner. To light the hall, the coil is first worked; then the gas is turned on, and the excitor applied to the several buttons causes sparks to be emitted at each burner, and thus enflames the escaping gas.

Revista de Telégrafos. No. 15, Anno xiv., August 1, 1874.

A great part of this number is taken up with a continuation of the article on the preservation of wood for telegraph posts, as translated from the TELEGRAPHIC JOURNAL. There is otherwise nothing of scientific interest.

No. 17. September 1, 1874.

Optical Nocturnal Telegraph.—Don Enrique Bonet.—The author has made public a system of nocturnal optical telegraphy, which, from its simplicity, and its great practical results, claims the attention of the press. The first trial of the system was made in August last, between Cadiz and Puerto-Real, points distant from each other 11 kilometres in a straight line, and under the disadvantages of imperfect apparatus, and of a violent storm, it was worked with success for the space of an hour, receiving perfectly all the words transmitted, and convincing all that the signals were visible at a much greater distance. The apparatus is composed of a lantern of wood, of a cubic form, 26 centimetres square. The front and back plates are of sheet iron, and can be opened. The front plate has in its centre a lens of 11 centimetres in diameter, of a hemispherical form, with its convexity turned outwards. This front is covered by a semicircular screen of tinplate, suspended from an axle in its centre. By means of this axle, which carries at its other extremity a handle, the screen may be made to turn round to the right or left so far as to touch two stops which limit its movements. The screen has at its extremities two square apertures, in one of which is placed a green, and in the other a red glass, so that when the screen reaches one or the other stop the corresponding glass is placed before the plano-convex lens. The motion of the screen is 60 degrees on each side. S. Bonet employs the Drummond light, the arrangements for producing which are well known to our readers. Though this system cannot compete with the electric telegraph for ordinary purposes, there are yet many circumstances, both in war and peace, when it may prove valuable.

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* Sabine's "The Electric Telegraph," p. 421.

Note on the Trial of Metallic Posts.—J. de la Taille. —The author, after describing the trials made on the Munich and Augsburg line, pronounces the system deserving of further trial, to which it is accordingly being subjected in France (*Journal Telegraphique*).

Telegraphy in Puerto-Rico.—J. O. Herrera.—An account of the extension of telegraphic lines in that island.

The statement is quoted from a foreign journal that M. Tommasi, the inventor of the hydroelectric cable for sending signals through pipes full of water, has succeeded in transmitting ten signals per second at a distance of two and a half miles.

No. 18. September 15, 1874.

The "Camacho" Electro-motor.—Several scientific men, at Habana, have been appointed to examine the electro-magnetic engine invented by J. S. Camacho, and to report on its advantages for industrial purposes in general, and especially as a motive power. In the "Camacho" electro-magnet each limb is formed of four hollow concentric iron cylinders, the inner one 13 millimetres in thickness, and the three remaining 7. The interior diameters of the tubes are respectively 48, 76, 106, and 127 m.m. Each of them is surrounded with a coil of copper wire, covered with cotton, and of 3 square m.m. in section, forming on the three inner tubes two complete layers with 180 turns, and on the outer tube seven layers with 630 turns.

The copper wire on each tube is coiled in the same direction, passing at its ends across the armature of the magnet, and uniting them therefore in the natural order, so as to form a single conductor through which the current from the battery may travel, magnetising each tube, and endowing them all with magnetism of an equal nature. The length of the limbs of the magnet is 212 m.m., its weight 35 kilos., and that of the copper wire 19 kilos., with a total length of 800 metres.

Repeated experiments have shown that this magnet requires the current produced by seven bichromate of potash elements, and its power of attraction at a distance ef 2 m.m. is more than 552 kilos. An electro-magnet of the ordinary construction, of equal exterior diameter, and placed in the same conditions, is only able to support 11 kilos., a weight 50 times smaller.

Repeated experiments of physicists as eminent and as well versed in electro-magnetism as De la Rive have shown that the main difficulty which hitherto has opposed the industrial application of the electro-magnetic force, has been that hitherto it has proved from 25 to 30 times dearer than that of steam. If, therefore, S. Camacho has succeeded in obtaining electro-magnets so powerful, the following proposition cannot be pronounced too venturesome:—"The new electro-magnets offer to industry a source of power much cheaper than animal labour, and capable of immediate application to urban railways. The same power is further destined, at no remote epoch, to replace advantageously that of steam."

The report is signed by D. Francisco Clerch, Professor of Physics and Chemistry at the College of Guanabacoa; D. En. de Aranlave, Inspector-General of Telegraphs for Cuba; D. Antonio de Molina, Engineer in Chief on the staff of the roads, canals, and harbours, and of public works; and D. Alberto de Castro, Civil Engineer.

Poggendorff's Annalen der Physik und Chemie.

Vol. LIV. (1841).

Research on the Action of Chemical Rays of Sunlight through Electric Currents. M. Becquerel. P. 18.

On Electric Action through the Influence of Solar Rays. M. Becquerel. P. 35.

On the Chemical Rays which accompany the Light of the Sun and the Electric Spark. M. Becquerel. P. 43.

On the Use of Light between the Poles of the Battery. M. de la Rive. P. 56.

On Electric Currents through Unsimultaneous Immersion of Homogeneous Metals. M. Schröder. P. 57.

On Electro-Dynamic Induction. Mr. Henry. P. 84.

On some Supposed Forms of Lightning. Mr. Faraday. P. 98.

On some Electro-Nitrogurets. Mr. Grove. P. 101.

Methods for Quantitative Determination of the Electromotive Force of Inconstant Galvanic Batteries. M. Poggendorff. P. 161.

On the Temporary Magnetism of Tempered Steel. P. 191.

New Researches on the Properties of Discontinuous Electric Currents with Alternately Opposite Directions. M. De la Rive. Pp. 231, 378, 477.

Galvanoplastic Copying of an Engraved Copper-plate. P. 300.

On the Currents Induced through Magnetisation of Iron by means of Frictional Electricity. M. Dove. P. 305.

On the Magnetism of the so-called Unmagnetic Metals. M. Dove. P. 325.

On some Electro-Magnetic Apparatuses. M. Jacobi. P. 335.

On the Question whether there are Actual Galvanic Batteries without Original Chemical Action, and on the Formation of Ferric Acid by the Galvanic Process. M. Poggendorff. P. 353.

Remarks on a Paper by Henrici on Galvanometry. M. Buff. P. 408.

Note on Secondary Currents. M. Henrici. P. 412.

On the Use of Carbonic Voltaic Batteries. M. Bunsen. P. 417.

On the Influence of Intermediate Plates in the Galvanic Battery. M. Buff. P. 503.

Rotation of the Light Current between the Poles of a Voltaic Battery. P. 514.

On Galvanic Batteries with Two Different Liquids, and on some of the Newest Researches on this Subject. M. Pohl. P. 515.

City and Commercial Notes.

In his last circular Mr. Abbott says:—The most striking feature in this market has been the further advance of 5 per cent in the value of Anglo-American stock. It is evident that those who purchased at the low quotations which recently prevailed have confidence in their investment, and are now satisfied to hold their stock notwithstanding the important advance which has since been established. This confidence is, however, not only justified by the revenue, but also by the character of the management of the Company.

Enquiries continue to be made as to the probable time when a further consolidation of telegraph shares will be brought into the Globe Trust. The impatience of shareholders is by no means to be wondered at, seeing that the present value of Globe ordinary and preference shares gives an average of £8¾, against £8½ for Eastern, £8⅛ for Eastern Extensions, and an equivalent of £8⅛ for Anglo-American Stock at £82; in other words, the brand of the Globe gives to the various properties a higher value, through the distribution of the risk, than they enjoy in their isolated and independent position. By late advices from the West Indies I learn that the new management of the West India and Panama Company continues to give satisfaction in that district. The *Trinidad Chronicle* of the 8th ult. says that the Company "continues to test the capacity of the line, and the efficiency of its working staff, by sending a test telegram through daily, from London to Demerara, with results eminently satisfactory."

Under date of October 9, M. G. Von Chauvin, Manager and Electrician of the Direct United States Cable Company, writes:—I am instructed by my board to inform you that on the 10th September, the cable forming the Ireland-Newfoundland section of this Company's line was, after 600 miles had been successfully laid from Ireland, broken in a heavy gale, owing to the *Faraday* having to haul back for a slight fault. Grappling was immediately commenced, but a succession of heavy gales, and the unfavourable state of the bottom, prevented the success of the operations, although the cable was brought to the surface on the second day after the accident, but slipped again on account of the exceedingly heavy sea prevailing at the time. The *Faraday* and her two tenders, the *Ambassador* and the *Dacia*, subsequently put into Queenstown, having run short of coals and supplies, and for the purpose of refitting parts of the picking-up gear, which was injured, owing to the rocky nature of the bottom, during the operation of grappling. The coaling and refitting of the three ships is now being pushed forward with the utmost despatch, and they will forthwith leave Queenstown, and proceed to the place of operations, when the contractors intend to abandon that short part of the cable which has been found to lie on rocky ground, and which extends over about 30 miles, and to effect the splice at a more suitable point, which has already been ascertained by soundings, and then to proceed to Newfoundland, avoiding the unfavourable bottom, and thus finish the work of laying our cables. My directors are of opinion, after having consulted with the contractors, that, taking all circumstances into due consideration, the laying of the Company's Ireland-Newfoundland cable will soon be completed. You will be pleased to learn that the sections of our cable which are actually laid, viz., the New Hampshire, Nova Scotia, and the Nova Scotia-Newfoundland sections, of an aggregate length of about 1100 nautical miles, show by the daily tests a perfect insulation and a high transmitting power, and are ready for use as soon as the Company's deep sea cable shall have been completed.

The directors of the Globe Telegraph and Trust Company, Limited, have declared the following dividends, payable on the 17th inst., for the quarter ending the 18th inst.—viz., 3s. per share on the preference shares, being at the rate of 6 per cent per annum, and 3s. per share on the ordinary shares, being also at the rate of 6 per cent. per annum. The books of the Company are closed from the 12th to the 17th inst., both days inclusive.

The Western and Brazilian Telegraph Company announce that, on and after the 15th inst., telegrams, in any language, can be prepaid to Buenos Ayres, the charge for twenty words being £12 3s. 8d., and half that rate for every additional ten words. Messages for places beyond, and the west coast of South America, should be addressed, "Oldham, Buenos Ayres," the further charges being collected from the receiver.

The traffic returns of the above Company have been as follows:—From opening of line to end of June, 1874 (for local traffic only), £16,000; since opening of Brazilian submarine line, giving communication with Europe, the returns show for July, £7668; for August, £8506; and for September, £6957. During September there was an interruption between Bahia and Pernambuco for seventeen days. Communication with the River Plate and West Coast of South America (save by land lines), also with the West Indies and North America, is not yet established, but vessels with completing sections leave in November. In future, traffic returns will be published monthly.

The Eastern Telegraph Company announced payment, on the 14th October, of the usual interim dividend of 2s. 6d. per share, free of income tax, for the quarter ended the 30th June, 1874.

The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the month of September, 1874, were £18,163, against £19,128, for the corresponding period of 1873.

The Eastern Telegraph Company's traffic receipts for the month of September, 1874, were £28,208, against £33,172 in the corresponding period of 1873.

The traffic receipts of the Great Northern Telegraph Company for the month of September were—This year, 427,121 francs; last year, 334,781 francs. Total traffic receipts from 1st January to 30th September—This year, 3,341,583 francs; last year, 2,388,131 francs.

The number of messages (of twenty words) passing over the Barcelona-Marseilles cable for the month ending September 30, 1874, were 5940.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Oct. 14.
Stock	Anglo-American (Limited)	100	77½—78½
10	Brazilian Submarine..	All	7⅝—7⅞
10	Cuba	All	6—6½
10	Direct Spanish	9	..—..
20	Direct United States Cable	All	11½—12½
10	Eastern (Limited)	All	8⅛—8⅜
..	Do., New	..	104—106
10	Eastern Extn. Australia and China	All	8⅛—8⅜
10	Globe Telegraph and Trust	All	7⅝—7⅞
10	Do., 6 per cent Pref...	All	10⅛—10⅜
10	Great Northern	All	10¾—11¼
25	Indo-European	All	17—18
10	Mediterranean Extension (Limited)	All	4—4½
10	Do., 8 per cent Pref...	All	10¼—10¾
10	Panama and South Pacific	2½	..—..dis
8	Reuter's..	All	11¼—11¾
Stock	Submarine	100	203—208
1	Do., Scrip	All	1⅞—2⅛
10	West India and Panama	All	3¾—4¼
10	Do., 10 per cent Pref.	All	10—10½
20	Western and Brazilian (Limited) ..	All	10¾—11¼
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	104—106
10	Hooper's Telegraph Works	All	12¾—13¼
50	India-Rubber and Gutta Percha ..	All	21—23
Cert.	Submarine Cables Trust	100	111—114
12	Telegraph Construction	All	29—30
100	Ditto Ditto 7 per cent Bonds	All	103—105

The directors of the Eastern Extension, Australasia, and China Telegraph Company, Limited, have declared an interim dividend for the quarter ending June 30, of 3s. per share, being at the rate of 6 per cent per annum, free of income tax, and payable on the 15th inst.

The directors of Reuter's Telegram Company, Limited, have declared the usual interim dividend at the rate of 5 per cent per annum, free of income tax, for the half-year ending the 30th June last. The warrants were payable on the 10th inst.

Patents.

Abridgments of Provisional and Complete Specifications.

372. T. Hopcraft, of London, Middlesex. *Improvements in telegraphic apparatus for transmitting messages or signals for ships, hotels, or other similar purposes.* Dated January 29, 1874.—This invention relates to improved arrangements of apparatus for telegraphic purposes, constructed so as to work by atmospheric pressure. The object of these improvements is to obtain a more ready and speedy method of transmitting messages, signals, or orders, than has hitherto been obtained on board ship or elsewhere by similar means.

380. G. T. Bousfield, of Sutton, Surrey. A communication from H. J. Smith, of Boston, Massachusetts, U.S.A. *Improvements in electrical machines.* Dated January 29, 1874.—The following are the claims to this complete specification:—1. A generating plate and a flat condenser placed parallel to each other within the same casing. 2. A Leyden jar or condenser constructed of vulcanised rubber and metallic plates. 3. So arranging the jar or condenser that the forward motion of the crank, to generate electricity and charge the jar, moves the jar forward through a small arc, whereby its terminals are moved away from the electrodes. 4. The device for discharging the jar by the retrograde motion of the crank, bringing the posts 3 and 2 into contact with the electrodes V and W. 5. Placing the firing points of the condenser at a distance from the collecting points. 6. The stop X limiting the forward movement of the jar. 7. The combination of a generating plate, a condenser, and a casing made air-tight, together with electrodes in the air-tight casing, and their projections by which the condenser is discharged. 8. The pouch O surrounding the machine proper. 9. The hard rubber cushions I and K, when constructed with springs. 10. The machine proper, when confined within annular metallic plates by bolts and screws.

2646. J. H. Johnson, of London, Middlesex, A communication from E. Gray, of Chicago, Co. Cook, Illinois, U.S.A. *Improvements in the method of and apparatus for transmitting musical tones by electricity.* Dated July 29, 1874.—This invention relates to a method of producing musical tones of any desired pitch at any point in an electrical circuit, and consists in transmitting a series of impulses of induced electricity of high tension, corresponding in number to the number of audible vibrations constituting said musical tone, through living tissue in contact with any resonant substance, or through a coil surrounding a bar of iron or the core of an electro-magnet, the succession of currents being produced by an induction coil or other apparatus for inducing a secondary current, and being caused by the action of any suitable circuit interrupter situated in a primary circuit.

415. J. Marchant, of No. 10, Dagmar Road, Camberwell. *Improvements in guard or safety signals for railway points or switches.* Dated February 2, 1874.—This invention relates to means of signalling to a pointsman the passage of a train over points distant from or invisible to him, so as to forbid his shifting the points while the train is passing over them. A counterweighted or spring trigger or slide is mounted close to the points, so as to be acted on by passing wheels, causing it to make and break contact with an electric wire leading to a visible or audible electric signal in the signal-box. The action of this signal informs the pointsman in the box that the train is passing the points, and he is thus warned against moving the points till the action of the signal ceases, the last wheel of the train having passed it.

439. H. Highton, M.A., of Putney. *Improvements in electric telegraphs.* Dated February 3, 1874.—This Provisional Specification describes obviating "retardation" in telegraph cables. At convenient places in the line, pairs of plates of metal or carbon are placed. These plates are arranged in the same manner as the plates in a galvanic battery, except that only one conducting liquid is used, and that the two plates in each pair are similar to each other.

440. S. J. Mackie, of No. 3, Delahay Street, Westminster. *Improvements in apparatus for signalling on railway trains.* Dated February 3, 1874.—This Provisional Specification describes a double electrical apparatus for signalling between the guards and passengers, by which an answering signal can be given, and the carriage from which the signal originates be pointed out to the guards. The apparatus signals to the guards if any of the couplings are imperfect. Provision is made for connecting to a train of carriages fitted with the apparatus carriages which are not so fitted.

447. J. Macintosh, of Westminster. *Improvements in materials for insulating telegraphic wires, part of which material is also applicable to covering other substances and rendering them waterproof.* Dated February 4, 1874.—The objects of the first part of my invention are to lessen the expense of materials for insulating telegraphic wires; and consists of mixing cotton-seed pitch with caoutchouc until it becomes a hot, plastic, nitrogenous mass, in which state it can be put on the wires by the machines used for that purpose. The second parts of my invention are to lessen the expense of waterproofing other substances, and consists of using cotton-seed pitch alone or in combination with other materials, and can be put on to cloth in a plastic place by rollers, or dissolved by its solvents and spread with a brush on surfaces, and in some cases it may be vulcanised.

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE TELEGRAPHIC JOURNAL" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER.

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